

Global Precipitation Measurement Mission

Water in the Atmosphere Teacher Guide

Lesson Overview:

This is an activity that was developed to give participants an understanding of the atmosphere. In this one-hour long activity, participants learn about the atmosphere by making observations and taking measurements. They will go outside and use scientific equipment to collect atmospheric moisture data (temperature, relative humidity, precipitation and cloud cover). Students will use this qualitative and quantitative data to understand how water is found in the atmosphere, how the atmosphere determines weather and climate, and how Earth's spheres are connected through the water cycle. The data collection is based on protocols from the GLOBE program: www.globe.gov.

Learning Objectives:

- Describe Earth's atmosphere using qualitative (words) and quantitative (numbers) information
- Interpret data to assess the state of moisture in the atmosphere
- Explain why the atmosphere is an important part of the water cycle

National Standards:

Core Idea ESS2.C: The Roles of Water in Earth's Surface Processes

- Water continuously cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation, and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS-4)

Core Idea ESS2.A: Earth Materials and Systems

- All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produces chemical and physical changes in Earth's materials and living organisms. (MS-ESS2-b) (MS-ESS2-c)

Background Information:

Water is fundamental to life on Earth. Knowing where and how much rain or snow falls globally is vital to understanding how weather and climate impact both our environment and Earth's water and energy cycles, including effects on agriculture, fresh water availability, and responses to natural disasters. Since rainfall and snowfall vary greatly from place to place, satellites can provide more uniform observations of rain and snow around the globe than ground instruments, especially in areas where surface

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measurements are difficult. In 2014, NASA will launch the Global Precipitation Measurement (GPM) satellite to collect precipitation data, improving the ability to know where and when rain is occurring. This lesson adapts protocols from the GLOBE Program (www.globe.gov) to help students get hands-on experience collecting scientific data about our atmosphere so they can better understand weather and the water cycle.

Many background facts can be found in the notes on the PowerPoint slides. These websites and resources may prove useful to get more detailed information. There are additional resources at the end of this lesson plan.

The Atmosphere Guide from The GLOBE Program

<http://www.globe.gov/web/atmosphere-climate/overview>

NASA's "The Air We Breathe" story book (PDF)

http://www.nasa.gov/pdf/62452main_The_Air_We_Breathe.pdf

USGS Water Science School <http://ga.water.usgs.gov/edu/watercycleatmosphere.html>

Materials:

To set up at least 24 hours in advance outside:

- Rain gauge <http://www.ambientweather.com/strgloteprra.html>

(note: If you do not have a rain gauge, you can still do this lesson by making a rain gauge. You can find directions for making your own rain gauge at this url:

<http://www.crh.noaa.gov/abr/?n=raingauge.php>)

- Thermometer – Taylor digital waterproof max/min thermometer (available at amazon.com) or any outdoor thermometer

To give to each group – in a bag for easy carrying

- pH paper strips – amazon.com
- sling psychrometer – amazon.com

To bring out to use for all groups

- container to pour rain water into and measure pH

To have inside

- an apple cut in half

Copies of the ["Atmosphere" student capture sheets](#)

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Engage:

Give students the student capture sheet. Show the students the picture from the [“Water in the Atmosphere” PowerPoint](#), either on the screen or print copies for groups to share, and an apple cut in half. Ask if they can determine what these represent. Record their ideas on the capture sheet then discuss in groups and as a class. (The blanket represents the atmosphere that surrounds Earth and we can compare the size of the atmosphere around Earth to the thickness of the skin of an apple.) (Slide 2)

Assess students’ prior knowledge about the atmosphere. Provide students with background facts about the atmosphere (using PowerPoint slides with notes, animations and video). Stress the connection to the water cycle and precipitation. (Slides 3, 4, 5, 6) Have students answer the engage questions on the capture sheet.

Ask the students how they think scientists measure water in the atmosphere. Gather their ideas and then show them the pictures or actual items that we will use to collect atmospheric data today. (Slide 7)

Explore:

Present our scientific question: “How much water is present in the atmosphere today?”

Divide students into groups of 3-4 and give each group pH paper and a sling psychrometer. The rest of the equipment should already be placed outside. Remind them to bring their capture sheets to record data, or at least one from the group. Bring the container to pour the rainwater into. Walk outside to the weather station and help the groups collect data. Students often need help understanding the units on the rain gauge (the numbers are millimeters) and will need help with the sling psychrometer, unless they’ve practiced this in advance. After all groups have recorded the rainfall in the rain gauge, pour the rain water into the container and let each group measure the pH of this water.

Explain:

Gather groups together (Slide 8) to analyze their results. Based on the data collected, have them answer the scientific question, “How much water is present in the atmosphere today?” using both qualitative and quantitative data. Students should discuss with their group and record their thoughts on the capture sheet. High humidity, high rainfall, and low, water filled clouds indicate a lot of water on that day. High wispy clouds, no rain, low humidity can mean less water. Remind the students that this data is just for today. We would need to collect this data over many days to get an idea of our weather patterns.

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Emphasize that we would need to collect data over a long period of time to gather information about the climate of an area.

Evaluate:

Discuss the following with the students: How is the atmosphere an important part of the water cycle? (Slide 9)

Elaborate/Extend:

- Hands-on activity to practice estimating cloud cover
<http://www.globe.gov/documents/348614/353086/atla-cloudcover.pdf>
- [“Measuring Precipitation” Lesson](#)
- [Weather and Climate IQuest](#)
- Make your own sling psychrometer (also has a chart for determining relative humidity)
http://www.teachervision.fen.com/tv/printables/TCR/0743936671_020-022.pdf
- Learn ALL of the cloud types
http://www.globe.gov/documents/348614/351665/atmo_ds_clouds1.pdf
http://science-edu.larc.nasa.gov/cloud_chart/
- Collect more atmosphere data or report your data to The GLOBE Program's Atmosphere Group
<http://www.globe.gov/web/atmosphere-climate/overview>
- Water pollution is greatly affected by air pollution
http://www.chesapeakebay.net/issues/issue/air_pollution#inline

Teacher Notes:

This lesson provides students with background information about the atmosphere and allows students to go outside and take actual measurements about water in the atmosphere. The data collection can happen with or without the background information.

For the best data collection experience, set the thermometer and rain gauge outside at least 24 hours in advance. Also, consider demonstrating use of the equipment before collecting the data in the field. The cloud-cover data has been simplified and only asks students to decide between four major types of clouds and generalizes their water content. Teachers

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can use the GLOBE Program cloud data sheet if they want their students to learn about all the types of clouds as categorized by scientists. The GLOBE Program has many training opportunities and offers a wide variety of different opportunities for students to collect authentic data and share it with other students around the world! Go to <http://www.globe.gov> and click “join” to learn more.

Additional Resources:

- Helpful information, background, and resources about the GPM mission and Precipitation Education <http://pmm.nasa.gov/education/>
- This 1:58 minute video segment provides an overview of Earth’s atmosphere and discusses atmospheric pressure and how it changes as astronauts enter space. http://www.nasa.gov/mov/217388main_080_Earth_Atmosphere.mov
- Precipitation module/lesson from the “Investigating the Climate System” series http://www.nasa.gov/pdf/62321main_ICS_Precipitation.pdf
- Clouds module/lesson from the “Investigating the Climate System” series http://www.nasa.gov/pdf/62317main_ICS_Clouds.pdf
- Weather and climate basics from the National Center for Atmospheric Research http://www.eo.ucar.edu/basics/wx_2.html